U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1601

COLLECTION AND PRESERVATION OF INSECTS

FOR USE IN THE STUDY OF AGRICULTURE

THE teaching of elementary agriculture, and especially that part which relates to beneficial or injurious insects, is much more effective when the course includes laboratory and field work and the use of illustrative material. The preparation of illustrative material of insects involves a knowledge of certain methods by which specimens may be properly prepared and arranged for study or exhibit. This bulletin gives general information regarding the methods of securing and preserving such material and also contains hints that may be useful to amateur collectors in caring for the specimens in their collections.

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COLLECTION AND PRESERVATION OF INSECTS FOR USE IN THE STUDY OF AGRICULTURE[1]

By MARGARET C. MANSUY,[2] *Senior Scientific Aid, Taxonomic Unit, Bureau of Entomology*

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THIS BULLETIN suggests methods of collecting, preparing, mounting, and preserving insect specimens for use by teachers of agriculture. It is intended particularly for those teachers who have not had special training along agricultural lines and who will therefore doubtless welcome specific information as to how to prepare materials needed for illustration and experimental use in the classroom.

WHAT MATERIALS SHOULD BE COLLECTED

In general, the illustrative materials with which every school should be provided may be grouped into two classes, according to the uses to which they are to be put: (1) Museum specimens and samples which are to be kept permanently for reference, display, and strictly illustrative purposes only; and (2) working collections, which may be used for display and illustration, but the chief purpose of which is to supply the students with materials for class study and experimental use. For instructional purposes the latter are far more valuable, but a permanent collection of insect specimens may be very useful to any school, provided, of course, the specimens are accurately labeled and so preserved and mounted that they are readily available for examination.

[1] This is a revision, in part, of Farmers' Bulletin 606, Collection and Preservation of Insects and Other Material for Use in the Study of Agriculture, by C. H. Lane and Nathan Banks. It was prepared by the author with the cooperation of the specialists in the Taxonomic Unit, Bureau of Entomology.

[2] Transferred to the Plant Quarantine and Control Administration July 1, 1928.

Materials for class use should as far as possible be fresh and in the natural state rather than in mounted form, and will therefore generally be collected just prior to the time they are wanted, and put away only temporarily. No great degree of care or skill will, in general, be necessary to do this, but the preparation of materials for the permanent collection in a school museum often requires considerable technical knowledge and ingenuity in preparing and preserving the specimens and preparing convenient receptacles in which to keep them. This is particularly true where the means at hand are limited and the resourcefulness of the teacher must be relied upon to produce inexpensive methods and devices of home manufacture.

SOURCES OF MATERIAL

It is good policy to attempt, as far as possible, to have the pupils collect and prepare their own materials from original local sources, because of the possibilities for educative work involved in the process of gathering the various specimens.

Every community affords opportunities for collecting insects of vital importance in the study of agriculture, and the work of gathering these specimens will afford definite tasks upon which to center the interest of numerous field trips, so that the danger of aimless wandering, which so frequently makes this method of instruction devoid of practical results, may be minimized. The instructor who takes his class out into the field or orchard with the definite purpose of collecting insects has the very best possible opportunity at the same time to teach, not only identification of the local insect species but also useful facts regarding their economic importance.

In recent years many commercial houses and educational institutions have distributed collections of specimens and samples of various sorts to schools. Such collections are of great value, undoubtedly, and there is no objection whatsoever to schools securing materials from such sources whenever possible, so long as they do not rely upon these sources for all their illustrative material.

GENERAL SUGGESTIONS FOR FIELD WORK

It is important that the pupils be provided with notebooks and pencils for making the complete and accurate records which should be kept for each specimen collected. These records supply the data necessary for the proper labeling of the mounted specimen.

All work of this sort should be constructive and never destructive. Wanton destruction of insects, except those which are injurious to man or his crops, should be denounced and the young encouraged to watch the living insects and learn all they can of their habits.

SUGGESTIONS CONCERNING THE ARRANGEMENT OF MATERIALS

When insects are collected for ordinary purposes of study and reference, it will usually suffice to arrange the specimens in their logical order, that is, according to their scientific classifications. When, however, it is intended to prepare a set of specimens for an educational display, very interesting and attractive groups can be arranged to show strikingly the agricultural relationships of the particular in-

sects in question. For example, a display might be centered about some farm insect pest which would show the insect in various stages of its development; specimens of the plants upon which it feeds, showing the injury it does to these plants; specimens of other insects which are hostile to it; and pictures of birds which prey upon it. It takes time to prepare exhibits such as this, but they are so much more attractive and instructive than an ordinary collection that the extra labor and thought involved in their preparation are fully warranted.

COLLECTION OF INSECTS

WHAT INSECTS TO COLLECT

When proper methods are followed, the collection of insect specimens can be made the basis of a great deal of useful instruction in connection with the subject of agriculture. There are numerous species that are really beneficial to the farmer, and these should, of course, be studied, but owing to the great number of species that are annoying about the house or injurious to farm animals or farm crops, insects are usually thought of as injurious to agricultural interests. These insect pests should form the basis of most of the work of the class in agriculture. It would be well, however, to make use of the forms which are most easily available at the season of the year when collections are being made and at the place in which the school is located.

In consideration of an insect from an economic standpoint all of its stages are important. It should therefore be the aim of the student of agriculture to observe the insect's habits and to preserve samples of all the stages in its life cycle. The pupil should seek to become familiar with each of the successive forms through which it passes in its development. In those insects which have a complete metamorphosis these forms are, normally, the egg, the larva (several stages), the pupa or resting stage, and the adult.

In addition to studying the cabinet specimens, field observations on the habits of living insects should be made. Such observations would include (1) the manner and place of deposition of the eggs, (2) characteristic work caused by feeding, (3) the selecting of places for hibernation, and (4) the relation of environment and season to the various steps in the development of the insect. In making such observations, samples to illustrate the feeding, construction of the nests, tunnels, galleries, or other architectural structures, as well as the cocoons or hibernating cells, should be preserved, as they will add greatly to the value and interest of the collection.

EQUIPMENT FOR INSECT-COLLECTING TRIPS

The articles necessary for collecting insects are not very numerous, and those which are most needed can be made by the pupils or the teacher with very little expense or trouble. The necessary equipment for an insect-collecting excursion should include collecting nets, killing bottles, a box containing some vials partly filled with alcohol, formaldehyde, or synthol, in which to place specimens of larvæ and pupæ, a trowel for digging specimens out of the earth, a small hatchet for breaking open rotten stumps, some sheets of newspaper or other

soft paper about 3 by 5 inches in size, for making envelopes in which to put delicate specimens of butterflies, moths, dragon flies, etc., a small bottle of chloroform or gasoline, and a small hand satchel or haversack with a few small pasteboard boxes, such as pill boxes, in which to put insects after taking them out of the killing bottle. A small pair of forceps or tweezers will also be found convenient for handling some of the specimens, and a pocket lens will be a desirable aid for the study of specimens in the field.

THE INSECT NET

Anyone can make a satisfactory insect net. (Figs. 1 and 2.) All that is necessary is a bag of thin material, a ring to support the bag, and a handle to be fastened to the ring. Bags are made of various materials. For beating through weeds and bushes it is best to have a bag of stout material, as twilled muslin or light duck cloth. For capturing butterflies and most flying insects a light net of cheesecloth or unbleached scrim does very well for the beginner. The material should be such as not to stiffen or kink by use. Expert collectors often use bags of silk bolting cloth. Damaged bolting cloth which is satisfactory for making insect nets can often be obtained from flour mills.

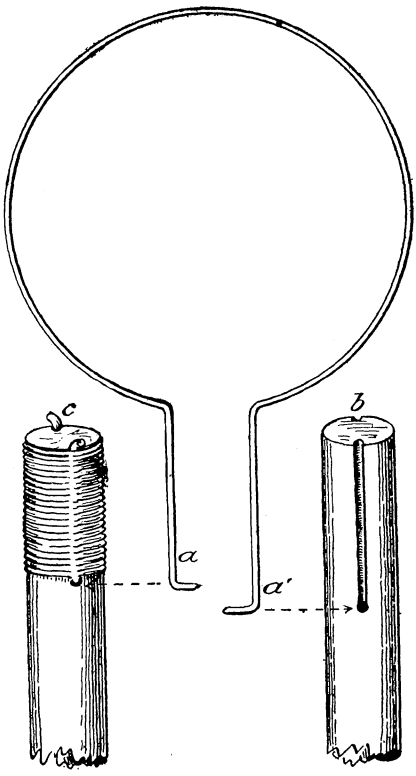

FIGURE 1.—Homemade ring and handle: *a a'*, ring; *b*, stick showing grooves ending in hole; *c*, wire inserted in groove and hole and wrapped with twine

As a rule the length of the bag should be twice its diameter. The common size is 1 foot in diameter and 2 feet long. The bag is best if made to taper a little at the bottom, and the edges should be double hemmed (French seamed) so as to leave no free edge that may fray out. If the bag is of light material, it should be sewed to a band of stout muslin at the top. This band should be double and open at each end for the insertion of the ring, or else sewed on the ring. The ring may be of stiff iron wire at least an eighth of an inch in diameter. Bought rings usually have two or three joints to allow for folding, but although this is convenient for packing it is not important. The wire should be several inches longer than necessary to form the ring, the extra length bent nearly at right angles, and the last half inch bent at right angles. The stick or handle, about 2 or 2½ feet long, should be stout but not too heavy. A groove

almost the size of the wire should be cut on each side near the end of the stick, ending in a hole, then the bent ends of the ring should be inserted in the hole and all wound tightly with twine, or a metal jacket slid over the ends to hold them in place. A longer and lighter handle of bamboo is better for collecting butterflies and dragon flies. It will be necessary to leave a few inches near the upper end of the bag unsewed so that the ring can be inserted in the band. This part can be laced up with a string and the ends of the string tied to the handle. This will keep the net from slipping around on the ring.

For catching small insects a "midget" net 5 to 7 inches in diameter is useful and can be made on the same plan as the larger one. The ends of the wire can be inserted in a spool and a stick for the handle wedged in between the ends of the wire. This net is very handy for collecting insects from flowers and, in fact, for general collecting. The material for the bag of the midget net should be very light; white China silk lining is a good material.

For collecting aquatic insects a more open mesh or sieve net can be attached to an iron frame which is straight on one side and bowed up on the other. With cords attached to each side this net

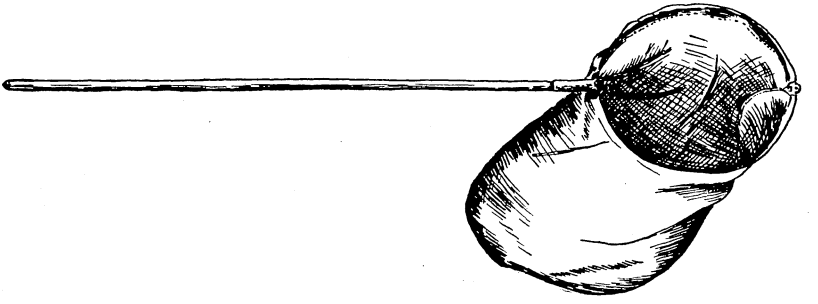

FIGURE 2.—Net for insect collecting

can be thrown into the water and after it has sunk to the bottom can be drawn to the shore. Dredging among the weedy or sedgy parts of the pond is especially productive of insects.

MISCELLANEOUS EQUIPMENT

Since many insects are attracted to lights, a strong lamp with a reflector to throw the light upon a white sheet will serve to attract many, particularly on sultry nights. A mixture of sugar or molasses and decaying apples smeared on trees in the woods will often attract moths and certain other insects at night. A good electric flash light or acetylene lamp is useful in examining these patches of sweetened bait in the evening. Many insects that occur on the trunks of trees can be captured easily by putting a small cyanide vial over them; thus one avoids handling the specimens.

For collecting insects from the branches and leaves of trees, a beating cloth is the most useful implement. It consists of a piece of heavy unbleached muslin a yard square with the corners turned over to form pockets. Two straight sticks about 5 feet long are placed cross-wise over the cloth with the ends placed in the pockets. To the

center of the sticks another stick can be fastened, so that the cloth can be more easily held out under the branch. The beating cloth should be held in the left hand at arm's length under the tree, and the limb jarred with a heavy stick. A sudden shock will dislodge many beetles and other insects that would not have been noticed upon the tree. An inverted umbrella can also be used for this purpose but is much less convenient and serviceable.

Cans or bottles sunk in the ground so that the top is even with the top of the soil and baited with meat, a dead mouse, rotten apples, molasses, etc., will be visited by various insects. Boards or pieces of bark left on the ground near the edges of woods and meadows will serve as shelters for a variety of insects, and if visited occasionally will disclose many interesting specimens. Stones, logs, or boards should always be turned back after they have been examined so that they will continue to attract insects.

Many insects occur among dead leaves and moss. These may be sifted out on a white paper or cloth by the use of a sieve similar to an ash sieve but with a finer mesh. Some empty salve boxes or larger tin boxes for caterpillars and other larvæ should be taken along on collecting trips. Care is necessary in taking insects from a net so as not to crush them or rub the scales from the wings of butterflies and moths. Specimens should always be handled as little as possible.

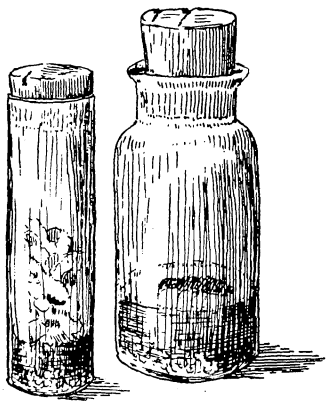

FIGURE 3.—Killing bottles

KILLING INSECTS

After the insect is caught it is necessary to kill it with as little pain to the creature as possible and without damaging the specimen. Insects are very differently organized from human beings, their sensations are perceived through much less perfect organs, and their brains are of such a very inferior nature that it is improbable that they feel much pain. Many insects can have their legs and other parts broken from them without incapacitating them in any way, and many kinds have parasites living within them and feeding on their internal organs without their exhibiting any sign of pain. There is no need, therefore, to feel that we are harming helpless creatures by collecting insects. Still, for the sake of the effect on the collector, it is not well to gather or destroy more than are necessary for this purpose.

The best way to kill insects is by cyanide vapor. Potassium cyanide and sodium cyanide are hard white substances which can be purchased at drug stores. Both are deadly poisons. The cyanide, if in chunks, should first be broken into small lumps. These are put into a bottle, covered lightly with dry plaster of Paris, and then plaster of Paris mixed with water is poured over them so as to cover the cyanide with a layer of set plaster about one-fourth of an inch thick. The bottle should be left open an hour or so to dry, and then

kept tightly corked so that the fumes of the cyanide will be strong enough to kill an insect in a few moments. (Fig. 3.) A label with the word "POISON" in large letters should be pasted upon it. It is well to place some crumpled strips of soft paper in the bottle to absorb any moisture and to prevent the insects from shaking against one another. A well-made poison bottle will last several years. The bottle should be of thick glass that will not break easily, with a wide mouth and a tight-fitting cork that does not set down too far to be conveniently grasped for removal. Some make a poison bottle by wrapping bits of cyanide in soft paper and covering all with blotting paper wadded down in the bottom of the bottle. This does very well for a small bottle, but one should be very careful to have bottles of thick, tough glass. As stated before, cyanide is a deadly poison, and the greatest care must be exercised in handling it. Any cyanide left over or any cyanide bottle which is broken should be buried deeply in the ground. Poison bottles should not be left open in the room or placed where small children can get at them, and older children should be impressed with the possible danger. It is best that the teacher should have all the bottles returned after each collecting trip.

Specimens should not remain in the poison bottle more than a day or two. In fact, insects with yellow markings should not be left in over night as the yellow may turn to red. Moisture should not be allowed to collect and remain inside the bottle, or it will quickly spoil many insects, such as dragon flies. Most entomologists use many small cyanide vials or bottles of only about one-half to 1 inch diameter and 2 to 4 inches long. By taking several of these along on a trip, it is possible to keep insects of different sizes and kinds separate, for small flies are likely to get broken if put into the same bottle with large, heavy beetles. Never put other insects in a bottle that contains or has contained moths and butterflies, as the other insects will become covered by loose scales from the moths or butterflies. It should be noted that bees and other hairy insects should not be put in alcohol.

There is much less danger in handling insects than is popularly believed, since comparatively few species are poisonous or are likely to injure the collector by biting or stinging. Insects like the wasps and bees will sting, of course; a few of the larger beetles may pinch or bite; and certain bugs may pierce the skin with their beaks, but all these are well known and easily recognized by most people.

PINNING INSECTS

Common pins are too large for most insects, and so entomologists use a longer and more slender pin. These pins can be purchased from dealers in natural-history supplies. They are made of brass or steel, plated or japanned. Spring-steel pins are stiffer and preferable except in very moist climates, where they are likely to rust. Steel pins cost a little more than brass pins but are much better for most insects, since specimens mounted on them will not become covered with verdigris. Verdigris is a poisonous green substance formed by the corrosive effect of acids in the specimen upon the brass pin inside the insect, and may ruin the specimen or eventually destroy the pin. The pins come in numbered sizes. No. 2 is a very good size

for most insects and No. 3 or No. 4 for the large ones. For use in school collections No. 2 will be the best size.

The larger insects, such as butterflies, moths, bees, and flies, should be pinned vertically through the body near the center of balance of the specimen. In butterflies and moths the pin must be through the middle of the thorax or the large wing muscles will not yield as the wings are moved in spreading them to dry. (Fig. 4.) It has been customary to pin several other groups of insects, like bees and flies, in the same manner, but whenever peculiar structures on the middle line will be injured by the pin, the latter should be inserted a little to the right of the median line. (Fig. 5.) Beetles (fig. 6) and many insects such as roaches, crickets, mantids, and large earwigs, are pinned through the right wing cover near the base. Walking sticks should be pinned through the metathorax (part of the body between middle and hind pairs of legs), or right tegmen (wing cover) if

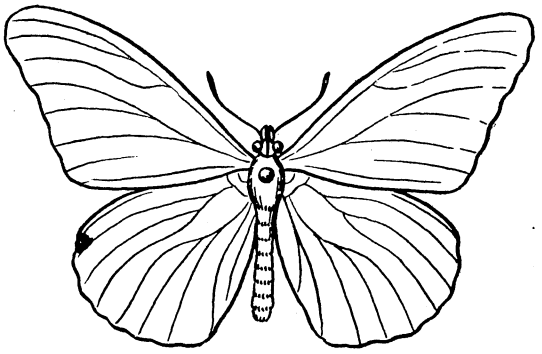

FIGURE 4.—Method of pinning butterflies

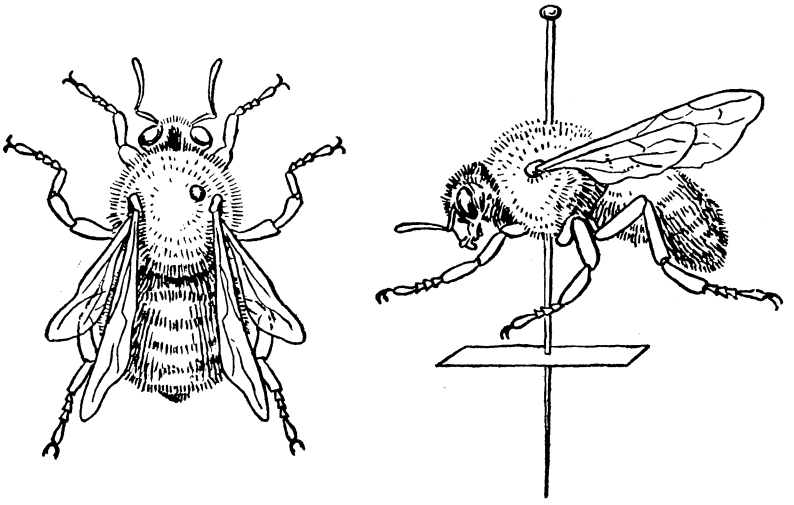

FIGURE 5.—Method of pinning bees

winged. Grasshoppers and katydids should be pinned through the base of the prothorax (the part of the body which carries the front legs) just to the right of the median carina, or keel; and in grasshoppers, etc., the left wings are frequently spread. (Fig. 7.) True bugs are pinned through the scutellum, or triangular portion of the thorax between the wings, slightly to the right of the middle line.

(Fig. 8.) The back of the specimen should be about an inch from the point of the pin.

Small moths should always be mounted on micropins (short pieces of slender wire having a pointed end) and spread as are larger moths.

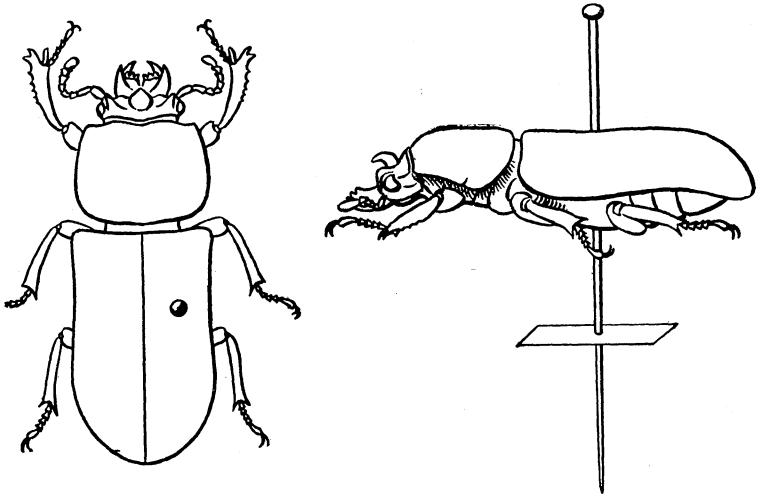

FIGURE 6.—Method of pinning large beetles

When dry such a specimen is attached to one end of a small oblong piece of cork supported at the other end by a larger insect pin, as in Figure 9, B.

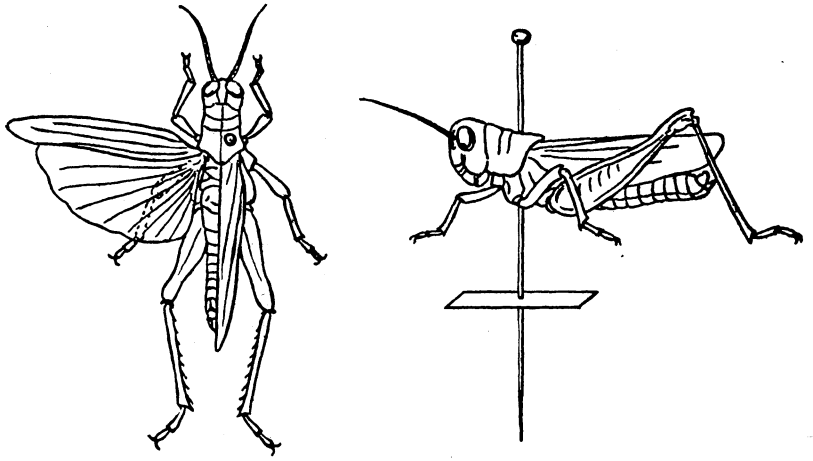

FIGURE 7.—Method of pinning grasshoppers

Small insects of most groups other than moths are best cemented onto triangular card points. The card points (about one-third inch long) may be cut from good stiff linen paper. A pin should be inserted through and close to the broad end, a little glue or shellac put on the point, and the insect laid upon it with the back outward

or upward and its head away from the preparator when the point is to the left of the pin. (Fig. 10.) It must always be remembered that specimens are mounted for study of their parts, and that neither the adhesive nor the paper point should cover more than is necessary to hold the specimen. Thus the practice for mounting small beetles is that the point with its droplet of cement should be applied to the metasternum (underside between the middle and hind legs, but should not reach the middle line. If specimens are large enough, the gummed point may be inserted into a small cut made in this plate (metasternum) with a flattened pin. Small bugs (Hemiptera) are also glued with the back up rather than on the side. Ants should always be mounted on card points, usually with three points on each pin. If possible, a male, a female, and a worker of the same species of ant should be mounted on one pin; but in any case the three specimens must be of the same species.

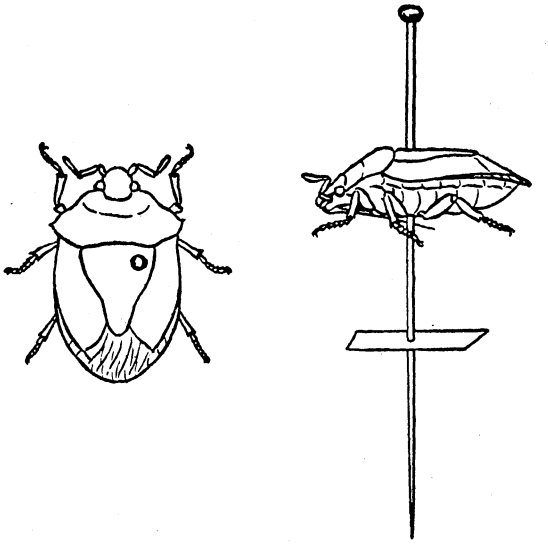

FIGURE 8.—Method of pinning bugs

It is very important that all specimens be correctly named before they are permanently assigned to a place in the school collection.

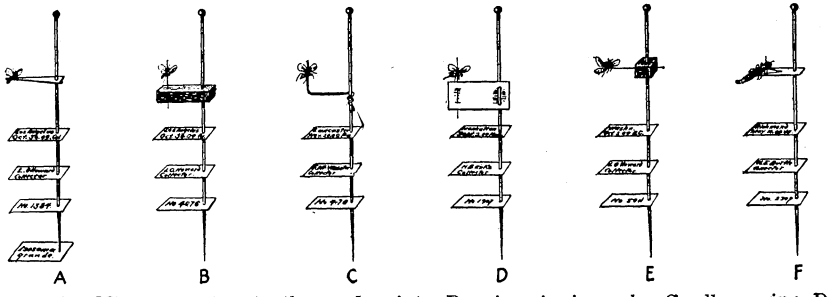

FIGURE 9.—Micro mounts: A, the card point; B, micropin in cork; C, elbow pin; D, micropin in card; E, micropin thrust through side of specimen; F, double card point

Entomologists usually have little 2-lined or 3-lined labels printed in very small type, giving the locality where the specimen was captured and a blank space for writing in the date of capture. These labels are put well up on the pin, a little below the insect, so as not to interfere with the legs. For school purposes labels may be written with a fine pen, care being taken to write them in a

small and neat hand. Insects found eating plants should have a little label giving the name of the plant, and the entomologist also usually places on a label the name of the collector of the specimen. Pupils should be impressed with the idea that carefulness in these little details counts in the value and usefulness of a collection. Additional information and aid along this line may frequently be had from the State agricultural college or experiment station or from officials of the State department of agriculture.

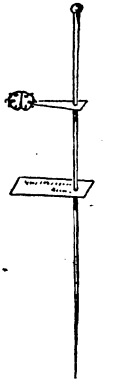

FIGURE 10.—Method of mounting small insects

SPREADING INSECTS

Insects should be prepared and mounted as soon as possible after they are collected, for if they are left for any length of time the wings and legs will become stiff and easily broken, and it will be impossible to spread the wings, as will often be desirable, in order to give the specimen a lifelike and attractive appearance. If it should be impossible to mount the specimens until they have become rigid, they can be relaxed by placing them for a time on a piece of paper in a box partly filled with moist sand. It will be well to put a few drops of carbolic acid on the sand in order to prevent molding. After being left in this way for two or three days the insects will usually be sufficiently relaxed to make it possible to mount them without great difficulty. Small insects such as microlepidoptera will only need to be left in overnight.

Butterflies and moths, dragon flies, and similar insects should have their wings spread out at right angles to the body. This is done by the use of a spreading board such as is shown in Figure 11. Two strips of some soft wood, such as linden, white pine, or yellow poplar, are fastened on low cleats resting on a bottom board. A strip of cork is fastened to the underside of the strips to cover the groove between them. The pin is pushed through the cork until the body of the insect rests upon it, and the wings are then stretched out on the boards by pulling them forward with a pin inserted near the front margin. They should be pulled out far enough so that the hind margin of the front wings will form a straight line. Then the wings should be held in place by strips of paper pinned down tightly at each end. The specimen should remain on the spreading board for at least a week, so that when removed the

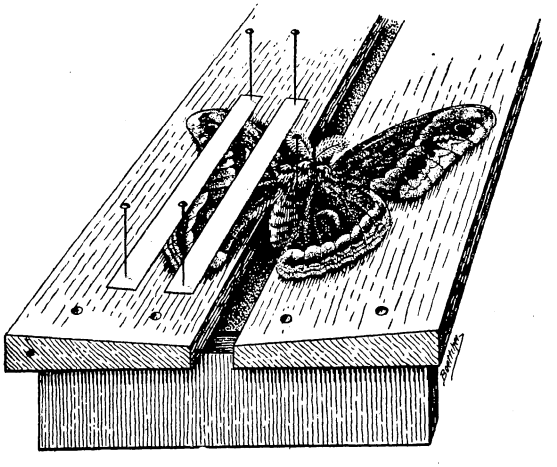

FIGURE 11.—Spreading board

wings will stay spread and not relax to the normal condition. Care should be taken in placing the strips across the wings, so as not to rub the scales from the wings of butterflies and moths. With grasshoppers it has been customary to spread the wings of one side only. Specimens of dragon flies on the spreading board should be dried as quickly as possible to preserve the body colors; to accomplish this the spreading board is sometimes placed in an oven and heated very gently. If heat is not applied, at least two weeks should be allowed for the dragon flies to dry before removing them from the board. Before mounting a dragon fly it is well to run a bristle through the head, thorax, and abdomen to keep the body from breaking apart, as is pretty sure to happen if this is not done.

FIGURE 12.—Covered box for insect specimens, commonly known as a Schmitt box

BOXES

If it is desired to keep the insects for several years, it is necessary to put them in a tight, dry, and dark box—tight to exclude other insects which would eat them, dry to prevent mold, and dark to preserve their colors.

There are two sizes of boxes commonly used by collectors. One is a box about 9 by 12 inches with a hinged top. (Fig. 12.) These may be stood on edge on a shelf. The other is a larger box or drawer about 15 by 18 inches with a removable glass top. These drawers are arranged to slide into a cabinet. Cabinets, with three or more

drawers, that will be excellent for school collections, can be purchased from dealers. For the purpose of temporary study insects can be kept in any style of box with a cover. Cigar boxes will do for a time (fig. 13), but are sure to become infested with insect pests if neglected long. The bottom of the box should be lined with some soft material, such as cork, peat, well-dried corn pith, or corrugated paper, and covered with soft paper. To prevent other insects from coming in and eating the specimens, a teaspoonful of flake or powdered naphthalene should be placed in each box. Within the box the specimens should be arranged, each kind by itself in a row. A label with the name of the insect can be placed behind the row of each species or attached to the first specimen in the row.

In recent years a new mount has been developed for exhibiting insects and their life histories, and it is most excellent for use in

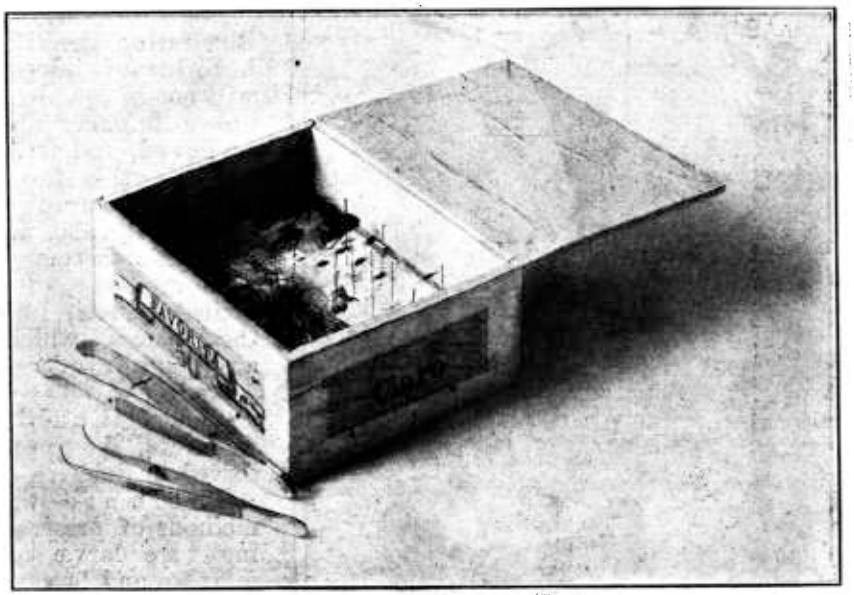

FIGURE 13.—Cigar box for insects

schools. It consists of a pasteboard box about one-half inch deep, the top having a glass cover. (Fig. 14.) This box is filled, not too tightly, with cotton. The insect is spread out on the cotton, the top pressed down and held by pins. These mounts can be purchased from dealers and are very useful for passing around in a class, or may be hung as pictures on the walls of the schoolroom. The eggs, caterpillar, chrysalis, and the adult, as well as part of the plant eaten, can all be put in the same mount and thus exhibit the life history of the insect.

FUMIGATION OF SPECIMENS

To fumigate the specimens perhaps the best way is to place in the box with the specimens a small tin lid or other small shallow vessel and put into it about a tablespoonful of the nonexplosive carbon

tetrachloride or of carbon disulphide. The fumes of the latter substance are inflammable and explosive when mixed with air in certain proportions and should not be handled near a fire. The fumes from these substances are annoying and disagreeable, hence it will be advisable to do this fumigating out of doors, or in an outbuilding—never in the schoolroom. Paradichlorobenzene, which is a white crystalline substance, is also a good fumigant, is not explosive, does not have so objectionable an odor as carbon disulphide, and can be used in much the same way as naphthalene.

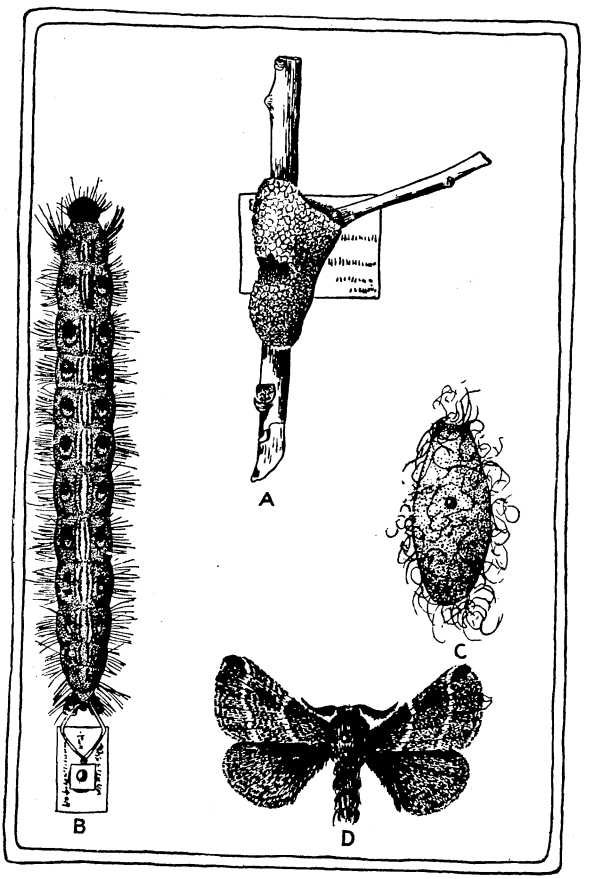

FIGURE 14.—Series of specimens illustrating life history of a moth: A, eggs; B, inflated larva; C, cocoon; D, adult

PRESERVING THE IMMATURE STAGES OF INSECTS

The specimens illustrating the life histories of insects will not be complete unless the larvæ are preserved, and it is often in this form that the creature is most injurious to crops. Furthermore, there are some soft-bodied insects, like the spiders, which are difficult to preserve dry.[2] These specimens should, therefore, be preserved in fluids.

There are two methods of preserving the larvæ of moths and butterflies—by inflation and drying or by placing them in solution. For the larger forms, particularly where these are to be used for demonstration or classroom exhibition, the former is preferred; but for all purposes of study of the caterpillars themselves the second is the better method.

To inflate larvæ, first put them on a piece of blotting paper and press out the body contents by rolling with a clean piece of glass tubing, starting from the thorax just back of the head and continu-

[2] Spiders, soft insects, and most larvæ can be dried without collapse by a modification of the Semper method, but as this demands the use of alcohol free from water (technically known as absolute alcohol) it can be practiced only where this is available. The method is to arrange and harden the desired preparation in a good fixative, thoroughly dehydrate by alcohol, puncturing tissues with a fine needle to prevent collapse from osmosis, clear in xylol, and dry.

ing to the end of the abdomen, exerting just enough pressure to force out the entire body contents and not enough to break off the fine spines or hairs. A piece of glass tubing which has been drawn to a rather long point is then inserted in the anal opening of the caterpillar and the caterpillar fastened to it by a clip or other piece of metal formed of a piece of watch spring. (Fig. 15.) The caterpillar is then distended by forcing air by hand or foot bellows into the tube, care being taken not to use too much force and thus distort the caterpillar. While in this condition it is dried in an oven hot enough to bake thoroughly without scorching the insect. Various types of apparatus for the blowing of caterpillars are to be had from entomological supply houses. The ingenious student, however, can easily make a cheap one of his own. All that is required is a spirit lamp, a tin can, a stand for same, glass tubing, a bit of watch spring, and a hand bulb or bellows. When the caterpillar is thoroughly dry it is removed from the glass rod and mounted. Figure 16 shows the best type of mount. A bit of glue should be put on the wire to hold the caterpillar in place. The advantage of this method of preservation is that the caterpillar can be pinned in the case along with the adult insects. When the inflation has been carefully done, the caterpillars present a lifelike appearance, retaining most of their spines, markings, and color.

FIGURE 15.—Tube for distending a caterpillar

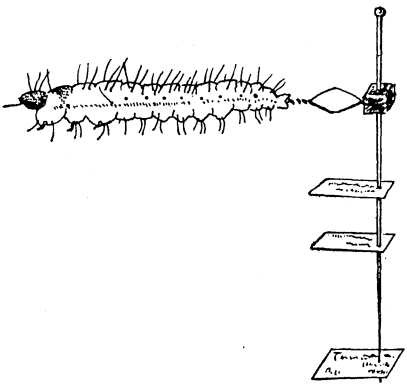

FIGURE 16.—Method of mounting inflated larvæ

The best method, however, for preserving immature stages—not only of moths and butterflies but also of beetles and flies—is in liquid preservative. The caterpillars or grubs are first killed by dropping them into boiling water, removing the water from the blaze, and allowing the insects to remain in the water for from three to five minutes, depending upon their size. They are then removed and placed directly in a solution of 80 to 95 per cent alcohol. For the smaller caterpillars and all fly larvæ the 80 per cent solution is best. For the larger caterpillars, whose bodies contain a considerable quantity of moisture, 95 per cent alcohol is to be preferred. To insure against shrinkage and to keep the body parts soft, a little glycerine—not over 2 ounces to the quart—should be added to the alcohol. Pupæ should be preserved in fluid in the same way as the caterpillars. In all cases where immature stages are preserved, whether by inflation or in fluid, they should be carefully labeled with full data as to locality, date, collector, and food plant; and where they are preserved in connection with rearing experiments, there should be some ready means of associating them with the adults.

MOUNTING MINUTE SPECIMENS

In determining all parasitic Hymenoptera (the order of insects containing bees, wasps, ants, etc.) it is necessary to see the antennæ, legs, propodeum,[3] dorsum (back or upper part) of abdomen, and wing venation. The wings, antennæ (feelers), and the legs of a part of the specimens should therefore be spread. This is especially true of the minute parasites belonging to the groups known as Chalcidoidea and Serphoidea. This can easily be done by taking the specimen from alcohol, placing it on its back on a clean microscope slide, and spreading the wings, antennæ, and legs with a brush while wet and then permitting them to dry. The specimen will dry in a very few minutes, and the parts will keep their position. It can then be mounted on a card point.

Only the very minute forms should be mounted in balsam. Those to be so mounted should be handled as follows: The specimens are killed in a solution containing—

	Cubic centimeters
Acetic acid (33 per cent)	62.5
Hydrargyri perchloride (liquid)	62.5
Glycerine	62.5
Alcohol (90 per cent)	500
Distilled water	312.5

They are kept in this solution until they are to be mounted, and will remain soft in it for years. Before mounting, the specimen is soaked in pure water for 24 hours. It is then placed in a drop of water on a cover slip and this put on a microscope slide. The slide with cover glass is placed under a binocular microscope and then the specimen is spread, as indicated above, upon the cover glass. While still damp the wings, antennæ, and legs are brushed over with a thin solution of gum arabic in water. This will dry immediately and fix the specimen to the cover glass. When thoroughly dry the specimen should be touched with a small drop of xylol and then covered with a drop of balsam. Let this balsam harden somewhat, then place another drop of balsam on the middle of the slide, pick up the cover glass with a pair of forceps, turn it over, and place it over the fresh drop of balsam. This brings the specimen with its back up, and if properly done will make a good mount.

KEEPING LIVE INSECTS—BREEDING CAGES

One of the most interesting phases of insect study is the rearing of insects. The simplest way is to collect the cocoons, attached to various trees in the fall, and the moths, red, brown, or pea green, will appear the following spring. It is more instructive, however, to collect the larvæ or caterpillars and place them in a box where they can be supplied each day with the proper kind of leaves for food. By this means one can watch the caterpillars change their skins while they grow, and also note the change from the caterpillar to the pupa or chrysalis. The last larval skin shed by the insect larva on pupating and the pupal skin should be saved, together with the adult that issues from it. Any box with a top of netting to prevent the cater-

[3] The part of the thorax immediately over and partly surrounding the petiole, or first segment, of the abdomen.

pillars from getting out will be suitable. By putting moist sand in the bottom of the box, the food will keep fresh a longer time.

A very convenient and useful breeding cage is made by putting a lamp chimney in a flowerpot (fig. 17), the top of the chimney covered with a piece of gauze or mosquito netting. If the pot rests in a saucer containing water the sand or earth in the pot can be kept moist so that the twigs of the food plant will remain fresh for some time.

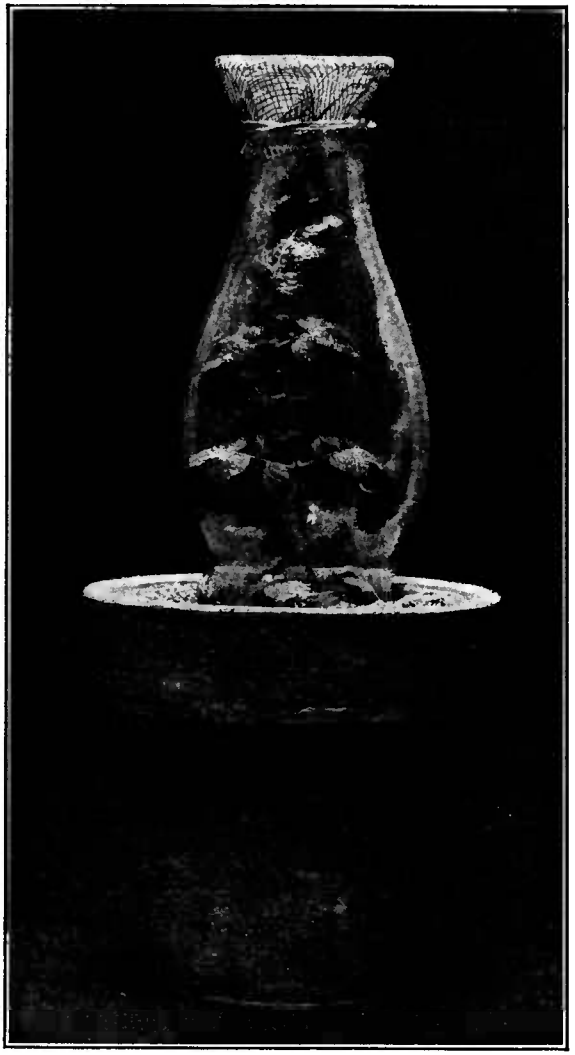

FIGURE 17.—A simple breeding cage for insects

It is interesting to keep ants in an artificial nest. A simple one may be made by taking a piece of board at least 1½ inches thick and about 12 inches square and making a channel 1 inch wide and three-fourths of an inch deep all around near the edge. This channel should be nearly filled with water. On the center of the board put two pieces of glass about 8 inches square and between them a thin layer of soil or comminuted wood. Cover the top glass with a blackened board or tin. Ants placed between the plates of glass will excavate tunnels and if fed may be kept a long time.

If galls of insects are collected in the fall or winter many specimens will issue in the spring. Twigs of oak and other trees blown off in the fall or winter may contain beetles, and if placed in a room the insects will issue and fly to the windows. In rearing moths or other insects one sometimes finds that instead of the expected specimen there appears a quite different insect. This is usually an ichneumon fly or tachina fly. The young of these live parasitically in the caterpillar and destroy it. These para-

sites should be saved and when possible the name of their insect host should be put on the label.

A good breeding cage (fig. 18) for parasites is a wooden box 10 or 12 inches long and 6 to 8 inches wide and of about the same depth. This box is fitted with an inner cover of glass and an outer cover of wood. One can therefore examine the material without permitting the escape of the insects. In one side of the cage several holes are bored and a glass tube fitted into each. The insects will be attracted by the light and come out into the tubes. The tubes can be quickly removed, the hole stopped with cotton, and the insects dumped into a cyanide bottle. For insects that pupate in the soil a layer of sand can be put into the bottom of this box.

Aquatic insects may be reared in a large Mason fruit jar, or a jar made especially for this purpose may be purchased from the dealers. Put some sand and pebbles in the bottom, fill with fresh water, and put in some fresh-water plants. The main difficulty is in the water becoming stale. All decaying matter and uneaten food should be removed with a pipette or long glass tube. It does not pay to try to keep too many kinds of insects in the same aquarium. Where a flow of water is available, a siphon outlet can be arranged and fresh water insured all the time. Many aquatic larvæ will not develop properly unless in running water. If near a stream, a cage of wire screening can be arranged over a stone or plant in the water on which are the larvæ of the desired insects.

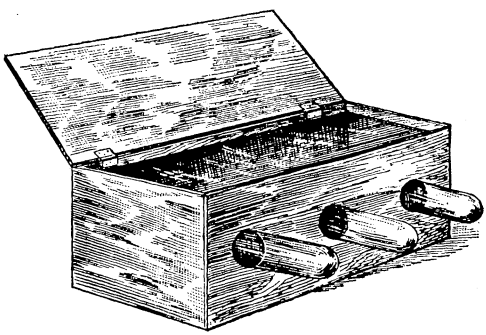

FIGURE 18.—A breeding cage for parasites

SHIPPING INSECTS

Probably many specimens will be discovered which can not be determined with the books available and it may be desired to send these to specialists for determination. To aid in building up collections it is often desirable to exchange specimens with other workers. To insure that these specimens reach their destination safely, they should be carefully packed for shipping. If the directions given below are followed, there is very little danger that specimens will be broken in shipping.

PINNED SPECIMENS

Pins must be firmly placed in the cork lining on the bottom of the insect box. All large and heavy-bodied insects should have a guard pin placed on each side and extending obliquely so as to meet above the top of the insect. This will prevent its moving on the pin which goes through the insect. The box containing the specimens should be wrapped with paper and then surrounded by at least 2 inches of some loose packing material, such as cotton or excelsior, which should in its turn be surrounded by a rigid covering. For comparatively small-sized packages corrugated paper makes a satisfactory covering.

Larger packages should be inclosed either in a stiff cardboard or light wooden box. The cotton or other material used for packing should not be put in too tightly, as its purpose is to absorb any shocks which the package may receive in transit. If the packing material is too tight, the purpose of it is lost.

ALCOHOLIC MATERIAL

In shipping material preserved in alcohol or other fluids, each vial should be tightly corked, wrapped in soft paper, and surrounded by some loose packing material. When only one or two vials are sent, they may be wrapped in cotton and placed in a wooden or pasteboard mailing tube manufactured for such purposes. The cotton packing around the vial should not be crowded in too tightly. When many vials are to be sent, they should be separated from each other by packing material and inclosed in a stout wooden or tin box.

In shipping specimens the usual directions required in connection with parcel post and express shipments should be followed. The word "Fragile" should be marked conspicuously on the wrapper. Always put the name and address of the sender on the package. Packages sent to foreign countries should be marked "Natural history specimens, no commercial value."

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July 24, 1929

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